THE

CAUSES OF DEATH

AFTER

OPERATIONS AND GRAVE INJURIES.

BY

THEODORE R. VARICK, M. D.,
SURGEON TO ST. FRANCIS'S AND JERSEY CITY CHARITY HOSPITALS.

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THE CAUSES OF DEATH AFTER OPERATIONS AND GRAVE INJURIES.[1]

It must have struck the observation of surgeons engaged in hospital practice, that death supervenes in a variety of forms, and under circumstances oftentimes the most perplexing, as well as distressing, and frequently unexpected.

This event has been variously attributed to shock, hæmorrhage, septicæmia, or pyæmia.

While recognizing these various causes as due to separate pathological conditions, we shall endeavor to elucidate the particular changes taking place in the blood and parenchymatous tissues, observed after death.

For the purpose of arriving at a proper discussion of the subject, I shall consider it under three aspects:

1. Influences operating upon and through the nervous system alone.

2. The combination of nervous influence and hæmostasis.

3. Influences operating primarily on the blood itself, resulting in parenchymatous changes and serous effusions.

These separate conditions, however, frequently graduate almost imperceptibly into one another to such an extent, that it is often almost if not absolutely impossible to distinguish the line of demarkation which divides the one from the other; and it is only by an observation of the case in

[1] Annual Address before the New Jersey Academy of Medicine, June 16, 1875.

its entirety that we recognize its varying pathological significance.

Authorities who have written on the subject have contented themselves with ascribing a fatal result to the general conditions alluded to, viz., shock, pyæmia or septicæmia, the last two of which have been included under the head of hospitalism, leaving the immediate cause of death undescribed if at all recognized.

The term shock has been employed somewhat loosely, and leaves a wide margin for theorizing and unsatisfactory discussion, as is apparent from the multitude of descriptions awarded to that condition, but few of which convey any satisfactory explanation as to the actual physical condition of the patient, simply detailing the apparent symptoms, leaving their interpretation to the greater or less sagacity of the observer.

So also as to the conditions of pyæmia and septicæmia. We are admonished, by a certain sequence of symptoms, that blood-poisoning exists, but as to the cause of its direful results, excepting one or two monographs on the subject, surgical literature is strangely deficient.

Death occurring under the second head has been entirely overlooked, so far as my investigation has gone, and it is on that account of special interest, and opens a wide field for observation.

Of the various definitions of *shock* I think that of Drs. Mitchell, Morehouse, and Keen, of Philadelphia, is more explicit, and conveys a better idea of the actual condition than any other.

Their explanation is as follows: "These very interesting states of system may be due, it seems to us, either to an arrest or enfeeblement of the heart's action, through the mediation of the medulla oblongata and the pneumogastric nerves; or to a general functional paralysis of the nerve-centres, both spinal and cerebral; or, finally, to a combination of both causes."

The phenomena resulting from this disturbance of innervation are manifested by a feeble and slow circulation, irregular respiration, indicating a diminished *besoin de respirer*, low temperature, demonstrating the existence of morbid changes in the red corpuscles, whereby their carrying power

of oxygen is to a certain extent destroyed; and, if the impression has been sufficiently powerful, resulting in the death of the patient.

After death from direct or primary shock, the heart is found gorged with blood, distended to its utmost capacity, together with general engorgement of the whole venous system.

The factors leading to death at this time are, the severity of the injury, the magnitude of the operation, the loss of blood, pain, and frequently the mental depression of the patient.

To so great an extent was the latter influence recognized by a late distinguished surgeon, that he used to caution his students never to operate on a patient who labored under an apprehension of impending dissolution.

The condition of shock may continue for a greater or less period, during which the patient may sink, or, rallying therefrom, pass into a gradual and progressive recovery; or, again, after having apparently recovered from the first impression, the pulse becomes more rapid and feeble, with slight increase of temperature, and in some cases no perceptible alteration in this respect, with occasional moderate delirium, and a sense of precordial oppression, may die apparently without any assignable cause.

This condition has been variously characterized as secondary or consecutive shock, and is one which should excite our gravest solicitude. It is during this period that the foundation is often laid for an unfavorable termination.

It is a condition most deceptive, and one which often excites a sense of false security or premature hope.

It should be more properly called prolonged or perpetuated paresis of the heart, great vessels and capillaries, and is a powerful factor in those pathological changes in the blood which result in organic changes inconsistent with the continuance of life.

On this subject Mr. Savory, in "Holmes's Surgery," remarks: "It has been often observed that recovery after severe shock is not always progressive. The symptoms sometimes fluctuate very obviously. A short period of improvement in

the pulse, respiration, and temperature, is succeeded by an interval of failing, and this alternation may recur again and again; each relapse, however, being less marked, until reaction is thoroughly established," or, as he might have added, more and more marked until death results.

There are instances which do occur, in which the recovery from shock, so far as we are capable of determining by any recognized process, is complete; yet, without any apparent cause, there supervenes a rapidly-failing pulse, and the patient dies.

In illustration, I would quote the case of Richard Wood, aged thirty-two years, native of Ireland, who was admitted to the Jersey City Charity Hospital, December 14, 1870, on account of compound comminuted fractures of both legs, the result of having been run over by a train of cars.

Amputation of both thighs at their lower thirds was performed by me, shortly after admission.

He rallied well from the shock and progressed favorably until December 18th, when he sank rapidly and died.

An autopsy revealed the presence of an *ante-mortem* clot, blocking up the pulmonary artery, producing almost total occlusion of that vessel, and extending into its bifurcation.

The house-surgeon had shortly before visited him and found no perceptible change, and while at dinner (about a half-hour later) was summoned to him, and found him in a dying condition.

In this case the immediate cause of death was manifestly thrombosis of the pulmonary artery, which in itself is to be considered simply as the result of some preëxisting cause; and this leads us to inquire as to the etiology of hæmostasis and its resulting effusions and parenchymatous changes.

In considering this branch of the subject, the various topics included under the second and third divisions are so intimately interwoven, that their separation would be not only injudicious but impracticable.

The causes leading to blood-stasis at this time, and those more particularly occasioning a perpetuation of the condition alluded to, are loss of blood, the use of anæsthetics, and also *malarial* influence—each in its way producing changes in the physical characters of the blood favorable to coagulation.

We have considered the condition of paresis of the vasomotor system of nerves as connected with primary shock, and if to this condition there be added an actual diminution of the quantity of blood, while the vessels themselves are dilated, or at least incapable of contracting on their contents, it becomes apparent that a condition favorable to coagulation and stasis results.

The draining off of a large quantity of the fluid, and with it the alkaline carbonates, whose office is to hold the fibrine in solution, is productive of the deposit of the latter element in the form of thrombi and emboli.

Although the use of anæsthetics has the effect of ameliorating shock, it also contributes to the last-named result, viz., changes in the blood itself.

On this subject Prof. Hüter remarks: "Under the microscope the corpuscles can be observed to become indented, first one and then another remains hanging on to the wall of the vessel, until at last all the capillaries in the irritated region, and even the adjacent small arteries and veins, are filled with notched, red corpuscles (globular stasis). Both during the existence of the stasis, and especially during its rapid breaking up, single altered corpuscles, or large masses of them, may pass into the circulation, and, adhering to the walls of the vessels in other organs, again produce stasis (globular embolism). The occurrence of embolism from blood-corpuscles in parts where certainly no change in the vessels has occurred, gives a certain degree of support to the assertion that the cause of globular stasis is to be sought in the changed condition of the red corpuscles." He further concludes that "the administration of chloroform is bad, as in this way the blood-corpuscles are altered while in the lungs, and globular stasis may be produced in these organs."

A further result of this state of paresis of the vessels and altered condition of the blood-corpuscles is a slow circulation, which in itself is favorable to coagulation, especially should there exist any asperity in the course of the vessels, or, as sometimes occurs from heart-strain, valvular lesion of the heart, which might act as a nidus for fibrinous deposit.

A nucleus having been formed, let it be ever so slight, the

subsequent accumulation goes on with increasing rapidity and consequent stenosis of the vessels.

I have observed that patients who have imbibed malarial poison, whether from a previous residence in fever districts, or from having been subjected to a sudden outbreak of the disease, are particularly liable to this mode of death.

Elias Colyer, aged forty-one years, native of the United States, was admitted to the Jersey City Charity Hospital, July 5, 1873, on account of compound comminuted fractures of both legs, the result of a railroad accident. Amputation of both thighs at their lower thirds was performed by me.

The patient progressed favorably. The ligatures came away on the tenth and twelfth days, and the wounds by the sixteenth day had healed by first intention to four-fifths of their extent.

What portion remained to heal by granulation was secreting a moderate amount of laudable pus. Appetite good; pulse, temperature, and respiration, normal.

His extremely favorable condition was such as to excite remark among the house-staff and attendants.

About the seventeenth day a trench was dug through the hospital-grounds, immediately under the windows of the ward occupied by the patient, giving rise to most offensive effluvia.

The result was an outbreak of intermittent fever, which attacked a number of patients, including the one in question, as well as the resident physician.

The patient was seized with a prolonged chill, with imperfect reaction. On the third day there supervened another chill, after which the patient sank, with rapid pulse and precordial oppression, and died on the twenty-first day after the operation.

On making a *post-mortem* examination, there was found a firm *ante-mortem* clot, involving the pulmonary artery from the right ventricle to beyond the bifurcation. The lungs were found congested, but every other organ healthy.

Superadded to the effects of shock, as previously considered, the blood-vessels are in a state of semi-paresis, during a paroxysm, while the condition of the blood, as shown by analy-

sis to exist under the circumstances, renders thrombosis particularly liable to occur.

James M——, admitted to St. Francis's Hospital, Jersey City, on account of necrosis of the tibia, for which he underwent amputation of the thigh at the lower third. Five days after the operation he was seized with chill, followed by fever and sweats, which assumed a tertian type. This continued until the twelfth day, when he died. During the last twenty hours the pulse ran up to 130 and 140 per minute, with great precordial oppression.

An autopsy revealed a firm *ante-mortem* clot of the pulmonary artery, and hæmorrhagic infarction of the lungs, while every other organ was normal. The stump had healed to about one-third its extent by first intention, and the remainder was granulating healthily, with a secretion of laudable pus.

At this time there were no cases of erysipelas or pyæmia in the hospital, but a number of cases of malarial fever, some of which had assumed a typhoid type.

It seems impossible to associate these cases with pyæmia or septicæmia in their ordinary acceptation, unless we adopt the view that malaria consists of organized vegetable germs (malarial spores), which at the present day exist more as a matter of theory than as an established fact.

He had suffered at stated periods for several years from intermittent fever. A portion of the time he resided in Illinois, in a region subject to the influence of paludal emanations; and at periods, when not suffering from the more characteristic evidences of the poison, was a victim to neuralgia in its protean forms, indicating a condition of constitutional cachexia due to the morbid influences to which he had been subjected.

It has been a matter of observation with me, that deaths occurring with similar attendant symptoms have been more frequent during seasons in which malarial fevers have prevailed. Of influences operating directly on the blood in determining its coagulation, none equal the admixture of purulent or septic material. Whether its reception be due to absorption, or the result of phlebitis, or whether it be of animal or vegetable origin, its effect on the circulating fluid is the same.

The experiments of Mr. Henry Lee are especially conclusive on this point, and they are of such a nature, and so philosophically carried out, as to establish the fact beyond a question.

The admixture of septic material with the blood produces its effect primarily on that fluid, while parenchymatous tissues are affected secondarily. The symptoms attending this contingency are as a rule so pronounced as to clearly indicate the changes taking place, and are such as are described in the various text-books under the heads of pyæmia and septicæmia.

Of the results following thrombosis and embolism, the most constant are those manifested in the lungs, in the forms of hæmorrhagic infarction, abscess, and serous or sero-purulent effusion in the pleural cavities.

Says Niemeyer, "Hæmorrhagic infarction consists in a capillary hæmorrhage, confined to a small and sharply-defined section of the lung, and often bounded by the limits of a single lobule. The blood is effused partly within the cavity of the vesicles and terminal bronchi, and partly lies in their interstices between the fibres of elastic tissue, by which the air-cells are entwined.

"The abrupt boundary of a hæmorrhagic infarction is caused by the fact that the bleeding comes only from the capillaries pertaining to a single twig of the pulmonary artery. The range of the capillary system of an artery depends upon its size; hence hæmorrhagic infarctions which arise within the capillary of a large branch of the pulmonary artery are far more extensive than one which forms about a smaller twig."

Ludwig has shown that "tension within the artery below the point of constriction is diminished, since the liquid flowing through a narrow tube loses more of its impetus than in flowing through a wide one.

"But we must not infer from this that, when an artery is constricted, the contents of its capillaries are lessened, and that the parts which they traverse grow paler. The sluggishness of the stream thus produced in the capillaries rather has the effect of allowing the heavy blood-corpuscles to collect and become crowded together: now, as two or more blood-corpuscles, if brought into contact, are apt to become perma-

nently adherent, the blood itself can form a plug capable of closing the capillaries. Such an occurrence, which converts the capillaries into blind appendices to the artery, must cause an increase in its internal pressure."

Hence we see by the foregoing quotations that, as the amount of infarction is governed by the size of the branch embolized, we should expect that, where the main trunk is obstructed by a thrombus, the whole lung should become congested, which is the fact.

In December, 1868, M. Prompt announced to the Société de Biologie that the kidney became hyperæmic when the renal artery was tied.

M. Moreau obtained similar results in the case of the spleen and intestines after ligature of the splenic and mesenteric arteries.

The experiments of M. Brown-Séquard, made on dogs and Guinea-pigs, show that even when all or nearly all the arterial supply of the kidney, the spleen, or a portion of the intestines, has been cut off, the district supplied by the arteries ligatured becomes remarkably congested; and he obtained the same result in the case of the liver on tying the portal vein.

This result is attributed by M. Séquard to paralysis of the vaso-motor nerve-filaments; and, further, that if the vaso-motor paralysis exists in any organ, and if the *vis a tergo* of the blood have ceased in it, in consequence of the interruption of the blood-current in the arteries, the diminution of resistance in the vessels of this organ will cause the blood to regurgitate thither through the veins and produce congestion.—(*Lancet*, 1872, p. 268.)

In illustration of facts just alluded to, I quote the following cases, omitting for obvious reasons the detailed report of each, simply contenting myself with a rapid sketch, and an account of the *post-mortem* appearances:

Dr. J. E. Culver reports the case of G. L. D., aged fourteen years, who sustained a compound fracture of the lower portion of the leg, which involved the ankle-joint. Amputation was performed at the junction of the lower and middle thirds. Symptoms of septicæmia supervened, which gradually in-

creased until the patient died, on the ~~eleventh~~ 21st day after the receipt of injury.

"*Sectio Cadaveris Sixty-seven Hours after Death.*—The body had been well preserved in an ice-coffin. It showed cadaveric rigidity, dilated pupils, moderate emaciation. The skin was a bloodless white, faintly mottled over the thorax and abdomen with patches of *post-mortem* icterus and purpura. The thoracic and abdominal cavities were exposed by the customary incisions. The cranium was not opened. Each pleural sac contained bloody serum, estimated at one-half pint; probably the greater part of it a *post-mortem* exudation derived from *ante-mortem* œdema of the lungs. No evidence existed of any former pleuritic or pulmonary disease. The pericardium was healthy and contained no excess of fluid. The heart was normal in position, size, and structure. Both its right and left cavities were, however, occupied by large decolorized thrombi, or strong bands of uneven breadth and thickness formed of fibrillated deposits of fibrine, which proved to be very firmly attached to the valves, the chordæ tendineæ and columnæ carneæ by contact surfaces and numerous tendrils. These thrombi partly filled the auricles and ventricles, and extended continuously through the auriculo-ventricular orifices, and through and beyond the ventriculo-arterial, and terminated by free extremities, the one in the aorta, the other in the pulmonary artery. They doubtless in divers ways impeded the circulation of the blood during the last days of the boy's life, and determined the time and manner of his death; for, as they grew in size, and their offshoots multiplied in number, and shortened their several points of attachment, they more and more choked the blood-streams, pinioned the valves, and in their ever-tightening grasp constricted both the systole and diastole of the heart. The very small quantity of blood that escaped from the heart and severed vessels was of venous color, and did not coagulate on exposure to air (hyperinosis, venosity, and quantitative anæmia). No *post-mortem* clots were seen. The liver was slightly softened. It was normal in size, shape, and position, and to the naked eye appeared healthy in structure, except in the site of a secondary abscess, the result of infarction, which was situated midway on the

anterior border of the lower surface of the right lobe, and which had by ulceration perforated its peritoneal covering. This abscess may have ruptured after death. The liver was not sliced thin and examined minutely throughout, and therefore other infarctions may possibly have existed therein which escaped observation. The spleen was large, soft, easily torn, in parts almost diffluent. The kidneys were normal, but the infundibula of both contained collections of pus, or mucopus, not of embolic origin."

Dr. B. A. Watson reports the case of Michael Noonan, mercantile traveler, who was admitted to St. Francis's Hospital, Jersey City, December 30, 1874, suffering from a compound comminuted fracture of the right foot and lower portion of the leg, the result of a railroad accident.

The man was of intemperate habits, and was in a state of intoxication when brought to the hospital.

Amputation was performed below the knee, after which he rallied well. Fifteen hours after the operation there supervened a rather profuse hæmorrhage, necessitating the reopening of the stump. It was found necessary to tie one small arterial branch, but the greater part of the blood lost was caused by a general oozing from every part of the flap. The hæmorrhage was subsequently controlled by the application of ice. The patient, notwithstanding the arrest of hæmorrhage, and a liberal administration of stimulants, etc., continued to sink, and died on the eighth day.

An autopsy revealed the presence of large, well-formed *ante-mortem* heart-clots, more especially on the right side; also thrombosis of the pulmonary artery and numerous points of infarction (in the lungs), of the hæmorrhagic variety. Nothing else was observed of special importance, unless possibly the softened and flabby condition of all the muscles, and the very large amount of adipose tissue everywhere present.

I am indebted to Dr. F. H. Whittemore, *interne* to Jersey City Charity Hospital, for the following report of the case of "Mary Burns, aged about seventy years, who was admitted to the hospital Christmas-evening, 1874, suffering from a compound comminuted fracture of both tibia and fibula in the lower third, involving the ankle-joint. Her condition was such

as to forbid a primary amputation being performed: consequently, not until Thursday, January 14, 1875, three weeks after the injury, was her limb amputated. The amputation was performed in the upper third of the leg, by the short anterior and long posterior flap method. The patient survived the operation well, and got along the first two weeks subsequent to the operation finely—all the ligatures having been removed, and the stump granulating well. About the beginning of the third week, however, she began to fail, as shown by frequent attacks of syncope, during which the heart-beat was very laborious and feeble. Her temperature rose at times from 100° to 103° during the remainder of her life, with pulse about 125 per minute. On Tuesday, two days previous to her death, she spat up a good deal of bloody-looking matter, which resembled very much the prune-juice expectoration of pneumonia. On auscultation, broncho-vesicular respiration, with mucous *râles*, was all that was heard—the examination not being very thorough, however, on account of the feebleness of the patient. She died on Thursday, February 4th, three weeks after the operation.

"*Autopsy Fifteen Hours after Death.*—Exterior: body well nourished, and stump nearly cicatrized. Lungs: on opening the left pleural cavity, it was found to contain a small amount of serous fluid, with a great deal of recently-deposited lymph on both the visceral and parietal pleura. The left lung weighed thirty-three ounces. In the pulmonary artery leading to it a large *ante-mortem* clot was found, which extended into its subdivisions. In the arteries leading up toward the apex, numerous emboli were found, the apex itself being transformed into an immense embolic abscess, which contained a good deal of sanious fluid and necrotic tissue. Near the base of the same lung, and in a portion supplied by one branch of the pulmonary artery, was a patch of hæmorrhagic infarction. The infarction was commencing to disintegrate, as, on cutting through it, a serous-like fluid exuded. Right side: pleura healthy. Lung normal in weight. A *post-mortem* clot occupied the primary artery. In one of its subdivisions an *ante-mortem* clot was found. At the bifurcation of one of the arteries going up toward the apex, an em-

bolus existed, which extended into both its branches, producing infarction in the tissues supplied by them. Heart normal in size. A large, firm, *ante-mortem* clot was found in the left side, firmly entangled among the trabeculæ, so that it was with difficulty removed. *Post-mortem* clots were found in the right cavities. Valves healthy. Other organs not examined."

Having thus rapidly considered the various causes leading to a fatal result, it is well to consider the actual condition at the time of death

1. As regards the nervo-motor system—*asthenia.*

2. As regards the blood-vessels themselves—*stenosis.*

3. As regards the condition of the blood itself—*extreme hypefinosis* and *hydræmia.*

4. As regards respiration—*a failure of blood-changes in the lungs.*

5. As regards parenchymatous tissues—*engorgement*, *œdema*, *infarctions*, and *secondary abscesses.*

It will be manifest that the limits of a single paper do not admit of more than a superficial review of the subject, and I hope to receive indulgence for the imperfect manner in which the topic has been discussed. I trust, however, that it may have the effect of arousing a spirit of inquiry, and that the subject may receive the attention and investigation it deserves.

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